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⑥4 **Method of manufacturing semiconductor device having package structure.**

⑤7 A method of manufacturing a semiconductor device having a package structure including a lead base and a cap includes the steps of: fixing a semiconductor chip (1) to a lead base (2); placing a fixation pellet (50) in a cap (6), the fixation pellet being made of a material which melts and is subsequently hardened by a rise in temperature; and placing the lead base carrying the semiconductor chip upside-down on the fixation pellet in the cap. Then heating of the fixation pellet between the cap and the lead base carrying the semiconductor chip is carried out to melt the fixation pellet and subsequently harden the melted fixation pellet. Thus, the lead base carrying the semiconductor chip is fixed to the cap to form a package structure.

Fig. 2C

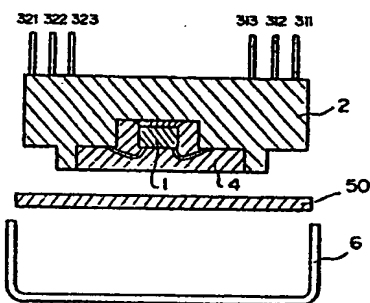
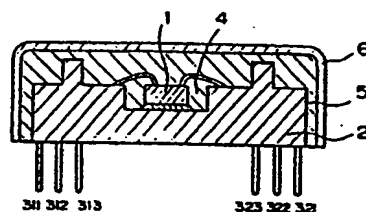


Fig. 2D



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METHOD OF MANUFACTURING SEMICONDUCTOR DEVICE
HAVING PACKAGE STRUCTURE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a method of manufacturing a semiconductor device having a package structure including a lead base and a cap. The method according to the present invention is applicable to the production of IC packages in the form of, for example, a pin grid array (PGA), a dual in line package (DIP), and a leadless chip carrier (LCC).

2. Description of the Related Arts

In general, a lead base for a semiconductor device having a package structure is made of highly heatproof thermosetting plastics such as heatproof epoxy resin, bismaleimide-triazine resin (BT resin) or polyimide resin. The lead base has a square shape in plan view, and a groove for mounting a semiconductor chip is provided in the center of the lead base. A barrier for preventing sealing plastics from reaching the side portion of the lead base is provided on the top surface of the lead base. Pins are provided at the bottom of the lead base, and these pins are connected to the semiconductor chip through wires.

In the production of the package structure, a liquid plastic for filling is disposed within a barrier on the top surface of the lead base including the groove, and the disposed filling plastic is hardened by curing. A thermosetting plastic solution such as an epoxy resin solution is used as the filling plastic, and the curing is carried out by raising the temperature.

Then, a thermosetting plastic solution for fixation similar to the filling plastic is disposed in the upside-down turned cap. The depth of the plastic solution for fixation becomes uniform with a lapse of

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time, and the device is turned upside-down and is fitted into the cap containing the plastic solution for fixation.

Then, the plastic solution for fixation is
5 hardened by curing at an elevated temperature to fix the cap to the device, and thus a package is produced.

However, a problem in the prior art production of the package structure is that the step of making the depth of the plastic solution for fixation uniform with
10 a lapse of time is troublesome, a perfect uniformity of the depth of the plastic solution for fixation is difficult to realize, and voids are apt to be generated in edge portions, which voids reduce the effective length of the water creepage path and thus deteriorate
15 the waterproofing characteristic. If such a water creepage occurs, a conductor in the electrical circuit of the device may be blown, and if water creeps into the voids in the edge portions, a leakage of current or a short-circuit may occur.

20 There is also a problem in that creeping of melted solder into the voids may occur, and there is a further problem in that the hardened plastic for fixation between the cap and the lead base may be forced out, to deteriorate the quality of the package structure as a
25 product.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved method of manufacturing a semiconductor device having a package structure including a lead base and a
30 cap for producing a high quality package structure at a relatively low cost by using a relatively simple processes.

In accordance with the present invention, there is provided a method of manufacturing a semiconductor
35 device having a package structure including a lead base and a cap including the steps of: fixing a semiconductor chip to a lead base; placing a pellet for fixation in a

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cap, the pellet for fixation being made of material which melts and is subsequently hardened by a temperature rise; and placing the lead base carrying the semiconductor chip upside-down on the pellet for fixation in the cap. Then, heating of the pellet for fixation between the cap and the lead base carrying the semiconductor chip is carried out to melt the pellet for fixation and subsequently harden the melted pellet for fixation. Thus, the lead base carrying the semiconductor chip is fixed to the cap to form a package structure.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, Figs. 1A to 1D show a prior art method of manufacturing a semiconductor device having a package structure;

Figs. 2A to 2D show a method of manufacturing a semiconductor device having a package structure in accordance with an embodiment of the present invention;

Fig. 3 shows a plan view of a lead base used in the processes shown in Figs. 2A to 2D;

Figs. 4A and 4B show plan views of the pellet for filling and the pellet for fixation used in the processes shown in Figs. 2A to 2D;

Figs. 5A to 5D show another embodiment of the present invention;

Figs. 6A to 6C show plan views of the pellets used in the processes shown in Figs. 5A to 5D;

Figs. 7A to 7D show another embodiment of the present invention;

Figs. 8A to 8C show plan views of the pellet used in the processes shown in Figs. 7A to 7D;

Fig. 9 shows another embodiment of the present invention;

Figs. 10A to 10D show still another embodiment of the present invention;

Figs. 11A to 11D show a further embodiment of the present invention; and,

Fig. 12 shows a plan view of the pellet used in the processes shown in Figs. 11A to 11D.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

((Description Concerning Figs. 1A to 1D))

5 Before describing preferred embodiments of the present invention, a prior art method of manufacturing a semiconductor device having a package structure is described with reference to Figs. 1A to 1D.

10 In Fig. 1A, the lead base 2 is made of a highly heatproof plastic such as a heatproof epoxy resin, or of a thermosetting plastic such as bismaleimide-triazine resin (BT resin) or polyimide resin. The lead base 2 has a square shape in plan view. A groove 21 for mounting the semiconductor chip 1 is provided in the
15 center of the lead base 2, and the semiconductor chip 1 is fixed to the bottom of the groove 21 by silver paste 11. A barrier 22 for preventing the sealing plastics 71 from reaching the side portion of the lead base 2 is provided on the top surface of the lead
20 base 2. Pins 311, 312, 313; 321, 322, and 323 are provided at the bottom of the lead base 2, and these pins are connected to the semiconductor chip 1 through wires 35 and 36.

In the production of the package structure, the
25 liquid plastic 71 for filling is disposed within the barrier 22 on the top surface of the lead base 2 including the groove 21, as shown in Fig. 1B. The disposed filling plastic 71 is hardened by curing. A thermosetting plastic solution such as an epoxy resin
30 solution is used as the filling plastic 71, and is cured by raising the temperature.

Then, a thermosetting plastic solution 720 for fixation similar to the filling plastic 71 is disposed in the upside-down cap 6 as shown in the lower portion
35 of Fig. 1C. The depth of the plastic fixation solution 720 becomes uniform with time. The device shown in Fig. 1B is turned upside-down as shown in the upper

portion of Fig. 1C and is fitted into the cap 6 containing the plastic fixation solution 720.

Then, the plastic fixation solution is hardened by curing at an elevated temperature to fix the cap 6 to the device; thus producing the package structure shown in Fig. 1D. At this time, the hardened fixation plastic 72 between the cap 6 and the lead base 2 is forced out as shown in the portion 72a.

((Embodiment of Figs. 2A to 2D))

10 A method of manufacturing a semiconductor device having a package structure in accordance with an embodiment of the present invention will be described with reference to Figs. 2A to 2D.

In Fig. 2A, the lead base 2 is made of a highly heatproof thermosetting plastic such as a heatproof epoxy resin, bismaleimide-triazine resin (BT resin) or polyimide resin, or ceramics such as alumina, silicon carbide, aluminum nitride, or mullite. The lead base 2 has a square shape in plan view, as shown in Fig. 3.
15 The groove 21 for mounting the semiconductor chip 1 is provided in the center of the lead base 2. The barrier 22 for preventing the filling plastics pellet 40 from reaching the side portion of the lead base 2 when melted is provided on the top surface of the lead base 2. The
20 pins 311, 312, 313; 321, 322, and 323 are provided at the bottom of the lead base 2, and are connected to the semiconductor chip 1 through the wires 35 and 36 made of, for example, gold or aluminum.

The filling pellet 40 is placed within the barrier
30 22 on the top surface of the lead base 2. The filling pellet 40 is made of a thermosetting plastic such as an epoxy resin, for example, E-pellet 6050 manufactured by Nitto Denko K.K. The size of the filling pellet 40 is such that, when the plastic is melted by a rise in
35 temperature, the melted plastic occupies the entire space within the barrier 22, including the groove 21. The material of the filling pellet 40 is preferably

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selected to be a plastic having a low viscosity, low thermal stress, and anti-thermal-mismatch property when melted, to enable the melted plastic to fill the corner portions of the groove 21 without exerting excessive force on the wires 35 and 36. A plan view of the filling pellet 40 is shown in Fig. 4A.

The filling pellet 40 is melted on the top surface of the lead base 2 and hardened by curing to form the plastic sealing 4 as shown in Fig. 2B.

10 Then the thermosetting plastic fixation pellet 50 is placed in the upside-down cap 6, as shown in the lower portion of Fig. 2C. The device shown in Fig. 2B is turned upside-down as shown in the upper portion of Fig. 2C and is fitted into the cap 6 containing the
15 fixation pellet 50. The fixation pellet 50 is, for example, an F-pellet 6050 manufactured by Nitto Denko K.K., or Ablefilm 564 manufactured by Ablestik Co. A plan view of the fixation pellet 50 is shown in Fig. 4B. The thickness of the fixation pellet 50 is about 0.8 to
20 1.2 mm.

By heating, for example, for 15 to 20 hours, the cap 6 is fixed to the device through the hardened plastic to produce the package structure shown in Fig. 2D.

25 ((Embodiment of Figs. 5A to 5D))

A method of manufacturing a semiconductor device having a package structure in accordance with another embodiment of the present invention will be described with reference to Figs. 5A to 5D.

30 In Fig. 5A, the lead base 2 is made of a highly heatproof plastic such as a heatproof epoxy resin, a thermosetting plastic such as bismaleimide-triazin resin (BT resin) or polyimide resin, or ceramics such as alumina, silicon, carbide, aluminum nitride, or mullite.
35 The lead base 2 has a square shape in plan view as similarly shown in Fig. 3. The groove 21 for mounting the semiconductor chip 1 is provided in the center of

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the lead base 2, and the semiconductor chip 1 is fixed to the groove 21 by silver paste 11.

The barrier 22 for preventing the melted filling pellet 40 from reaching the side portion of the lead base 2 when melted is provided on the top surface of the lead base 2. The pins 311, 312, 313; 321, 322, and 323 are provided at the bottom of the lead base 2, and are connected to the semiconductor chip 1 through the wires 35 and 36 made of, for example, gold or aluminum.

The filling pellet 40 is then placed within the barrier 22 on the top surface of the lead base 2. The filling pellet 40 is made of a thermosetting plastic such as an epoxy resin, for example, E-pellet 6050 manufactured by Nitto Denko K.K. The size of the filling pellet 40 is such that when the plastic is melted by a rise in temperature, the melted plastic occupies the entire space within the barrier 22, including the groove 21. The material of the filling pellet 40 is preferably selected to be a plastic having a low viscosity, low thermal stress, and anti-thermal-mismatch property when melted, to enable the melted plastic to fill the corner portions of the groove 21 without exerting excessive force on the wires 35 and 36. A plan view of the filling pellet 40 is shown in Fig. 6A.

Then, a frame pellet 80 for the preliminary sealing is placed outside the barrier 22 on the peripheral top surface of the lead base 2. The frame pellet 80 is, for example, an F-pellet 6050 manufactured by Nitto Denki Kogyo K.K. applied to a non-woven glass sheet and having a thickness of about 40 μ m to 200 μ m. A plan view of the frame pellet 80 is shown in Fig. 6B. The thickness of the frame pellet 80 is about 0.2mm to 0.5mm.

The filling pellet 40 and the frame pellet 80 are then melted on the top surface of the lead base 2 and hardened by curing to form the filling plastic 4 and the preliminary sealing layer 8 as shown in Fig. 5B.

Then, the thermosetting plastic fixation pellet 50

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is placed in the upside-down turned cap 6 as shown in the lower portion of Fig. 5C. The device shown in Fig. 5B is turned upside-down as shown in the upper portion of Fig. 5C and is fitted into the cap 6 containing the fixation pellet 50. The fixation pellet 50 is, for example, an F-pellet 6050 manufactured by Nitto Denki Kogyo K.K. and applied to a non-woven glass sheet. A plan view of the fixation pellet 50 is shown in Fig. 6C. The thickness of the fixation pellet 50 is about 0.5mm to 1.0mm.

Thus, by raising the temperature, the cap 6 is fixed to the device through the hardened plastic to produce the package structure shown in Fig. 5D.

((Embodiment of the Figs. 7A to 7D))

A method of manufacturing a semiconductor device having a package structure in accordance with another embodiment of the present invention will be described with reference to Figs. 7A to 7D.

In Fig. 7A, the filling pellet 40 and the frame pellet 80 for the barrier formation are placed on the top-surface of the lead base 2. The materials of the filling pellet 40 and the frame pellet 80 are similar to those of the filling pellet 40 and the frame pellet 80 in the case of Fig. 5A. Plan views of the filling pellet 40 and the frame pellet 80 of Fig. 7A are shown in Figs. 8A and 8B. The thickness of the frame pellet 80 is about 0.3mm to 0.7mm.

Thus, by a temperature rise, the frame pellet 80 is melted and hardened to be fixed to the lead base 2 to form the substantive barrier 8 for the filling pellet 40 to be melted within the range surrounded by the frame pellet 80. Thus, the filling by the melted and hardened plastic 4 is carried out as shown in Fig. 7B.

Then, the thermosetting plastic fixation pellet 50 is placed in the upside-down turned cap 6 as shown in the lower portion of Fig. 7C. The device shown in Fig. 7B is turned upside-down as shown in the upper

portion of Fig. 7C and is fitted into the cap 6 containing the fixation pellet 50. The material of the fixation pellet 50 is similar to that in the case of Fig. 2C. A plan view of the fixation pellet 50 is shown in Fig. 8C.
5 The thickness of the fixation pellet 50 is about 0.2mm to 0.5mm.

Thus, by a temperature rise, the cap 6 is fixed to the device through the hardened plastic to produce the package structure shown in Fig. 7D.

10 Instead of the arrangement shown in Fig. 7A, it is possible to adopt the arrangement shown in Fig. 9. The thickness of the frame pellet 80 is similar to that in Fig. 7A.

((Embodiment of Figs. 10A to 10D))

15 A method of manufacturing a semiconductor device having a package structure in accordance with another embodiment of the present invention will be described with reference to Figs. 10A to 10D.

In Fig. 10A, the filling pellet 40 is placed on the
20 center of the top surface of the lead base 2, including the groove 21. The material of the filling pellet 40 is similar to that in the cases of Figs. 2A, 5A, 7A, and 9.

Thus, by a temperature rise, the sealing of the central portion of the device including the groove 21,
25 the semiconductor chip 1, and the wires 35 and 36 is carried out to form a hill-shaped plastic filling 4 as shown in Fig. 10B.

Then the fixation pellet 500 having a projecting portion 501 is placed in the upside-down turned cap 6 as
30 shown in the lower portion of Fig. 10C. The device shown in Fig. 10B is turned upside-down as shown in the upper portion of Fig. 10C as is fitted into the cap 6 containing the fixation pellet 500. The material of the fixation pellet 500 is similar to that in the cases of
35 Figs. 2A, 5A, 7A, and 9. The thickness of the central part of the fixation pellet 500 is about 0.3mm to 0.7mm. The thickness of the projecting portion 501 is about

0.8mm to 1.2mm.

Thus, by raising the temperature, the cap 6 is fixed to the device through the hardened plastic to produce the package structure shown in Fig. 10D.

5 ((Embodiment of Figs. 11A to 11D))

A method of manufacturing a semiconductor device having a package structure in accordance with a further embodiment of the present invention will be described with reference to Figs. 11A to 11D.

10 In Fig. 11A, the filling pellet 40 is placed within the barrier 22 on the top surface of the lead base 2. The material of the filling pellet 40 is similar to that in the cases of Figs. 2A, 5A, 7A, 9, and 10A.

15 Then, the filling pellet 40 is melted on the top surface of the lead base 2 and hardened by curing to form the plastic filling 4 as shown in Fig. 11B.

20 Then the fixation pellet 550 is placed in the upside-down turned cap 6 as shown in the lower portion of Fig. 11C. The device shown in Fig. 11B is turned upside-down as shown in the upper portion of Fig. 11C and is fitted into the cap 6 containing the fixation pellet 550.

25 The fixation pellet 550 is constituted by a resin and non-woven glass sheet portion 551 made of, for example, an epoxy resin such as an E-pellet 6050 manufactured by Nitto Denko K.K., and a non-woven glass sheet 551, and an exclusive non-woven glass sheet portion 552 without plastic surrounding the plastic and non-woven glass sheet portion 551. A plan view of the
30 fixation pellet 550 is shown in Fig. 12.

Thus, by raising the temperature, the cap 6 is fixed to the device through the hardened plastic to produce the package structure shown in Fig. 11D. The glass-sheet-only portion 552 serves to absorb the melted plastic when
35 the temperature is raised, so that an extrusion of the melted plastic to the outside of the configuration of the package structure of Fig. 11D is prevented.

CLAIMS

1. A method of manufacturing a semiconductor device having a package structure comprising a lead base and a cap, comprising the steps of:

fixing a semiconductor chip to a lead

5 base;

placing a fixation pellet in a cap, said fixation pellet being made of material which melts and subsequently is hardened by a rise in temperature;

10 placing said lead base carrying said semiconductor chip upside-down on said fixation pellet in said cap; and

heating said fixation pellet between said cap and said lead base carrying said semiconductor chip to melt said fixation pellet and subsequently harden the
15 melted fixation pellet;

whereby said lead base carrying said semiconductor chip is fixed to said cap to form a package structure.

2. A method according to claim 1, further comprising a step of preliminarily filling a space around said
20 semiconductor chip in said lead base with filling material, between said step of fixing said semiconductor chip and said step of placing said lead base carrying the semiconductor chip upside-down on the pellet for
25 fixation in the cap.

3. A method according to claim 2, wherein said preliminary filling is carried out by placing a filling pellet on said semiconductor chip portion on said lead base, melting said filling pellet and hardening the
30 melted filling pellet.

4. A method according to claim 3, wherein said preliminary filling is carried out within the range defined by a barrier formed on the surface of said lead base.

35 5. A method according to claim 4, wherein said barrier is a part of said lead base.

6. A method according to claim 2, further comprising the steps of:

placing a frame pellet on the peripheral top surface of said lead base, and

5 heating said frame pellet to melt the frame pellet and subsequently harden the melted frame pellet to fix the hardened frame pellet to said lead base.

7. A method according to claim 2, wherein a
10 preliminary sealing of a space around said semiconductor chip by melting a filling pellet and a formation of a barrier by melting a frame pellet and fixing the melted frame pellet to said lead base are carried out simultaneously.

15 8. A method according to claim 6, wherein the planar size of the frame pellet for forming the barrier is smaller than the planar size of the lead base.

9. A method according to claim 2, wherein said preliminary filling is carried out on the free top
20 surface of said lead base by melting a filling pellet and subsequently fixing the semiconductor chip to the cap is carried out by melting a fixation pellet having a projecting portion between the semiconductor chip and the cap.

25 10. A method according to claim 4, wherein said pellet placed in the cap is constituted by a plastic and non-woven glass sheet portion and an exclusive non-woven glass sheet portion surrounding said plastic and non-woven glass sheet portion.

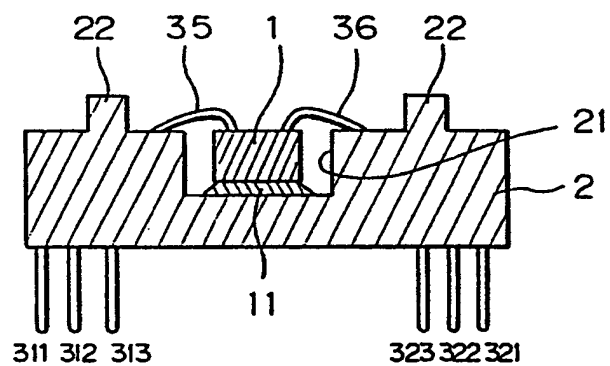
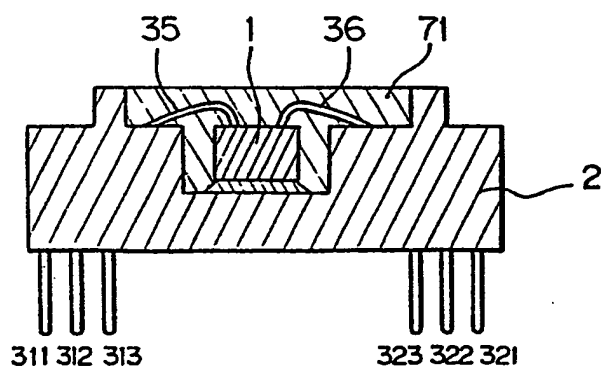
Fig. 1 A*Fig. 1 B*

Fig. 1C

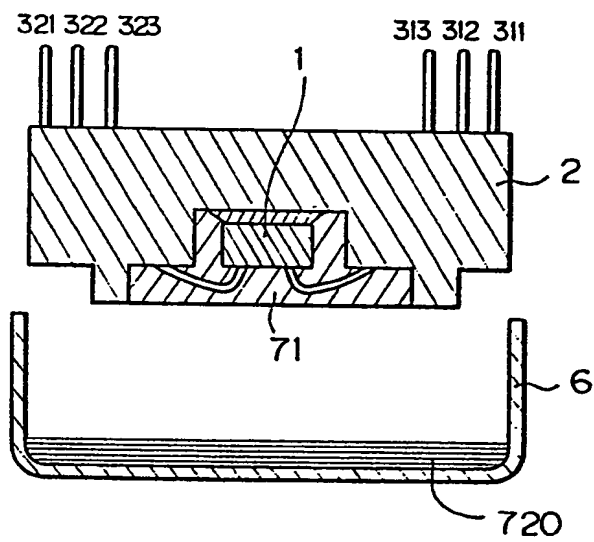


Fig. 1D

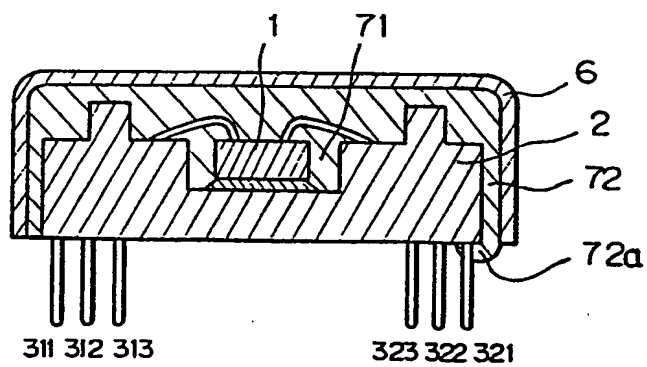


Fig. 2A

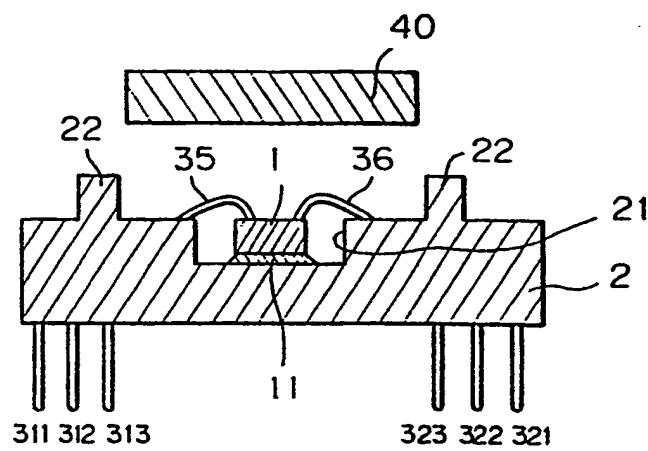
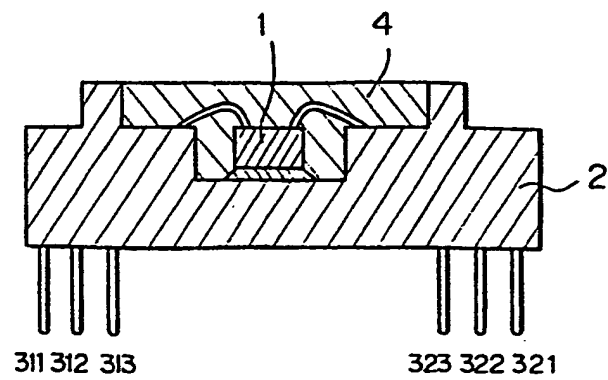


Fig. 2B



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Fig. 2C

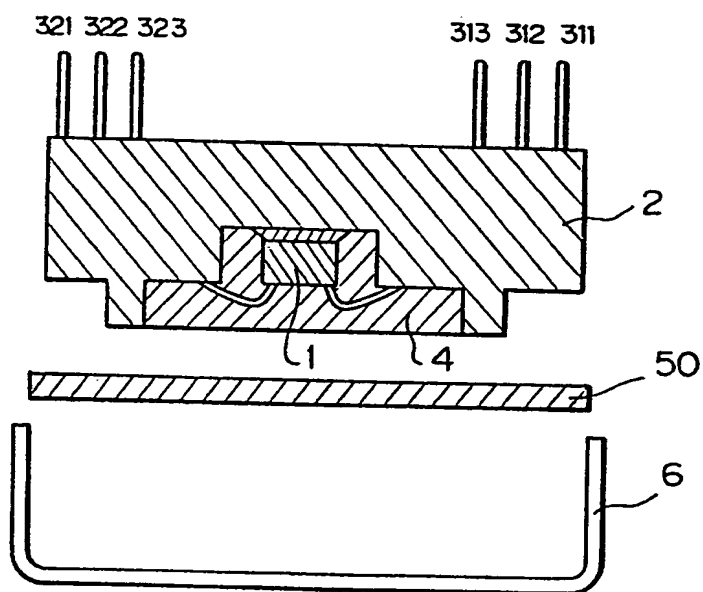


Fig. 2D

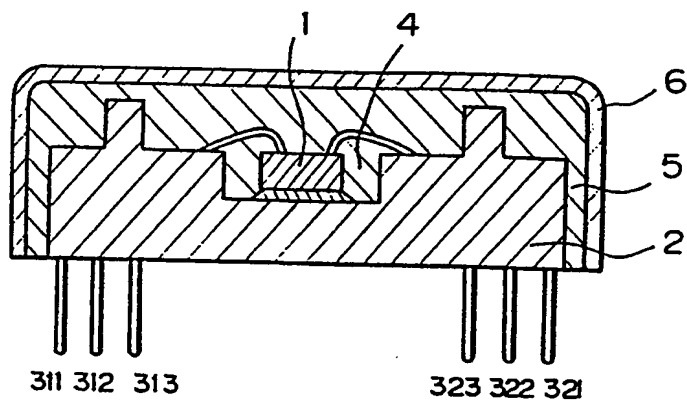


Fig. 3

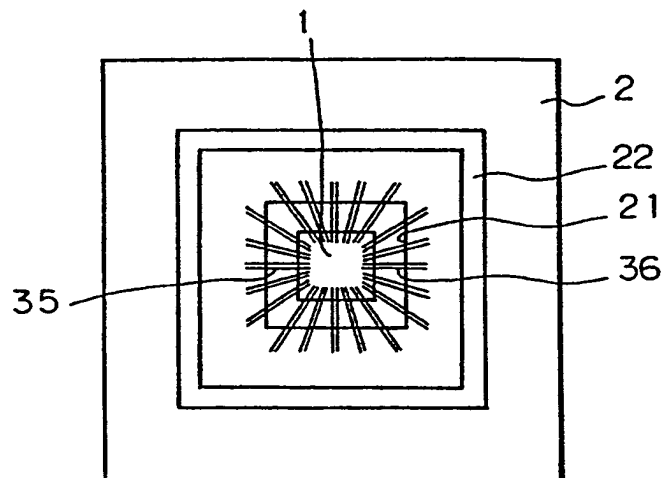


Fig. 4A

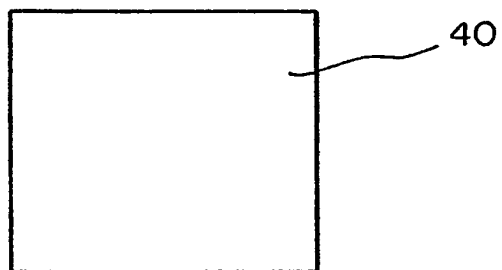


Fig. 4B

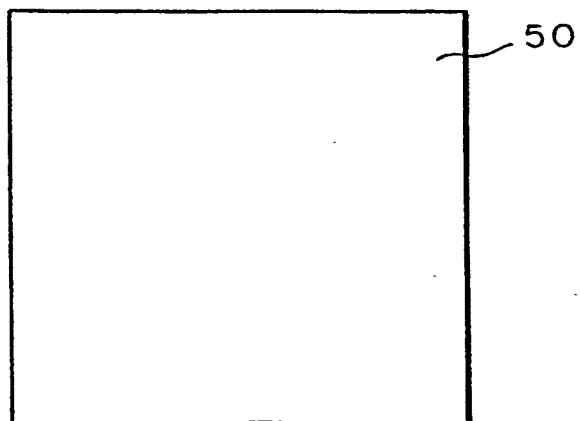


Fig. 5A

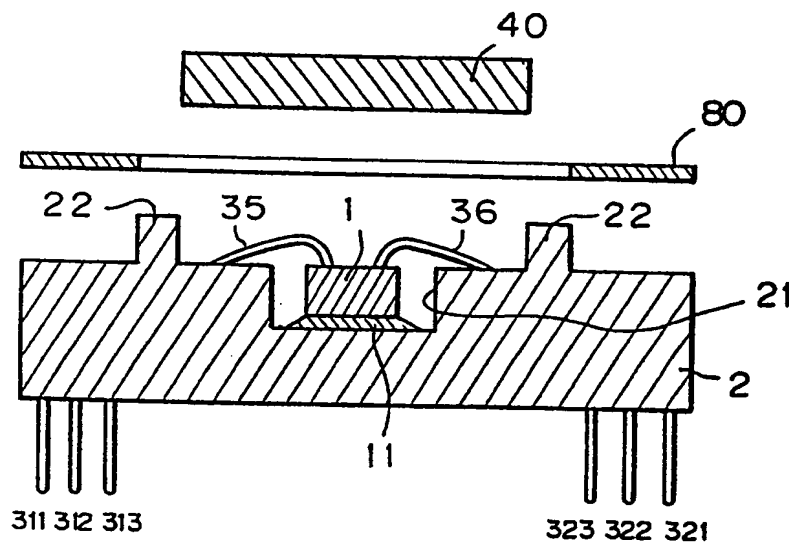


Fig. 5 B

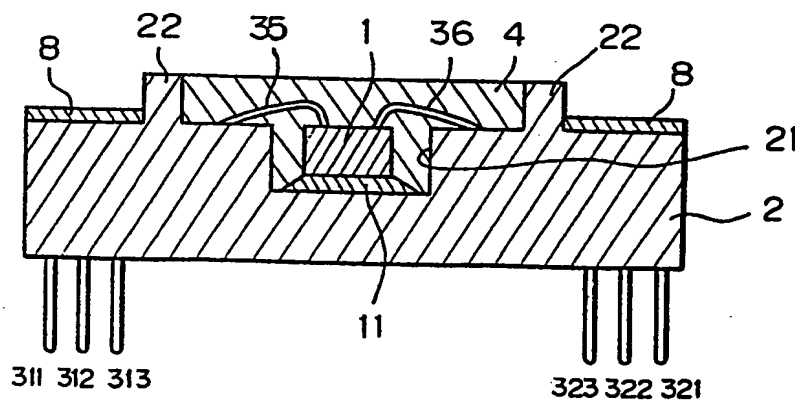


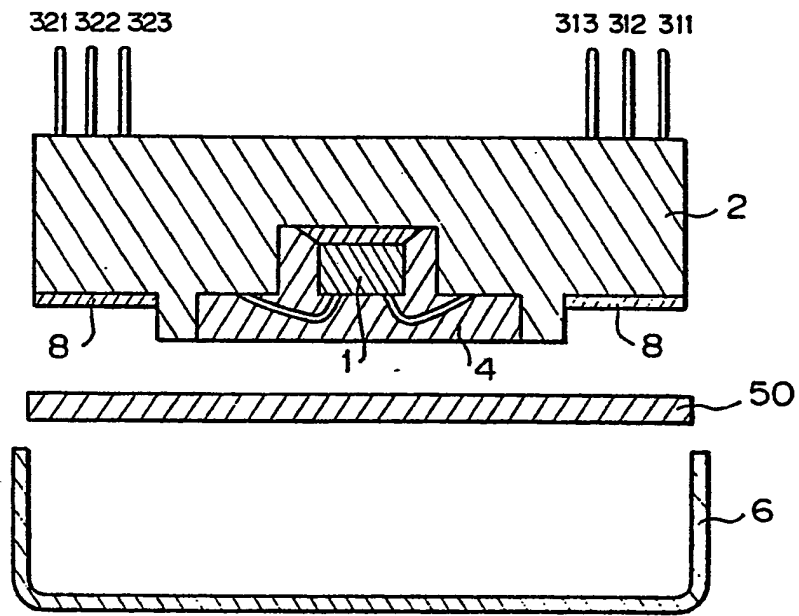
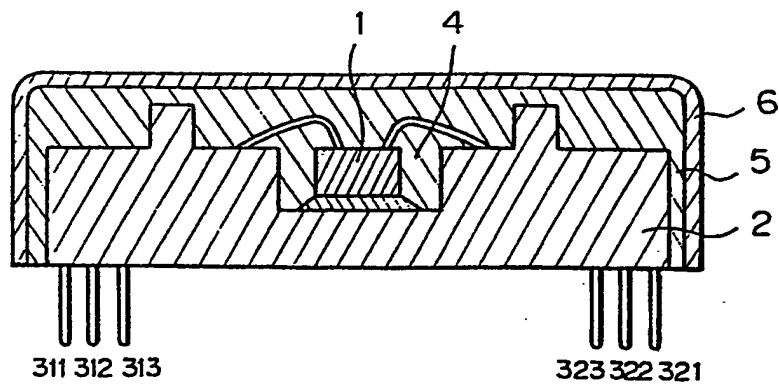
Fig. 5C*Fig. 5D*

Fig. 6A

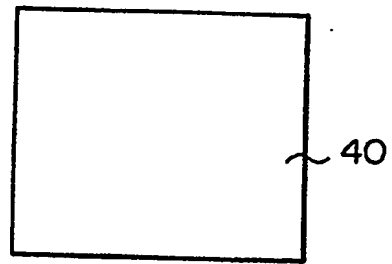


Fig. 6B

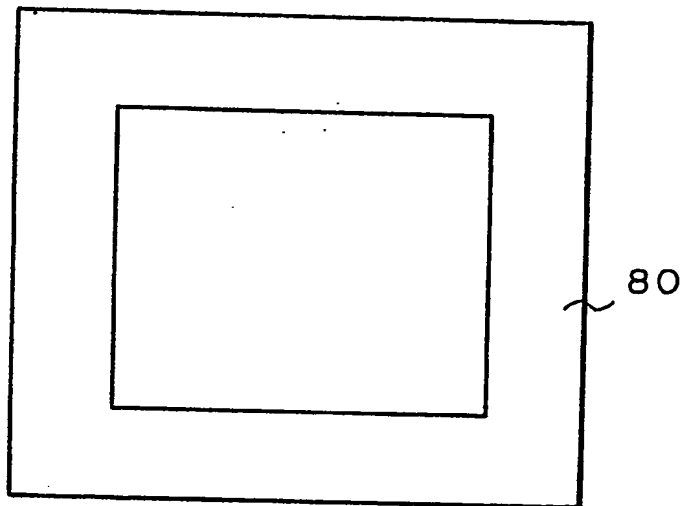


Fig. 6C

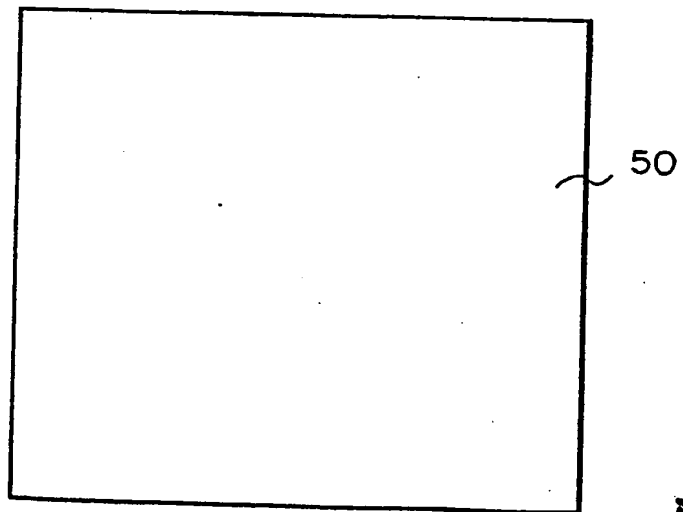


Fig. 7A

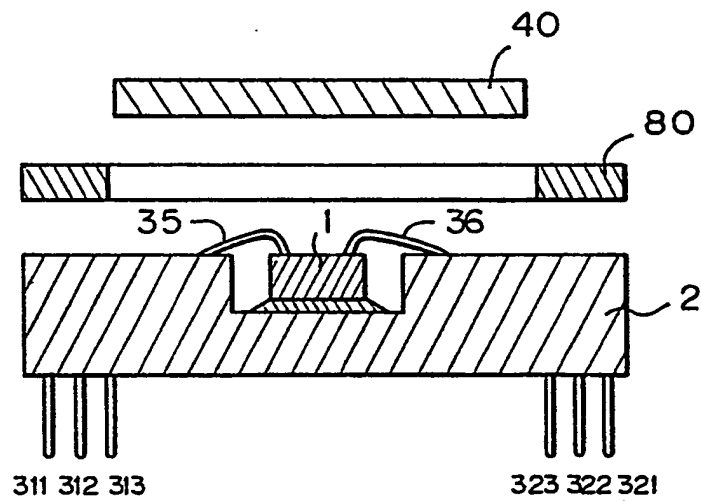


Fig. 7B

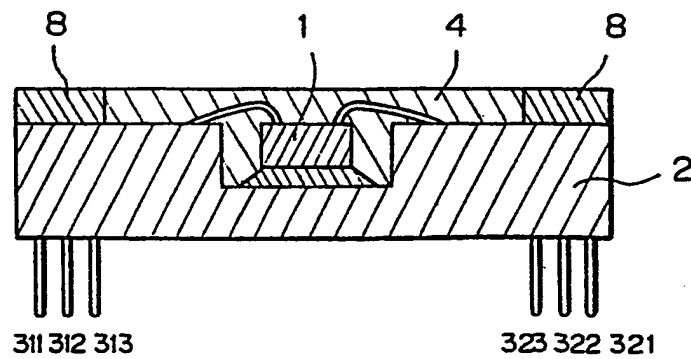


Fig. 7C

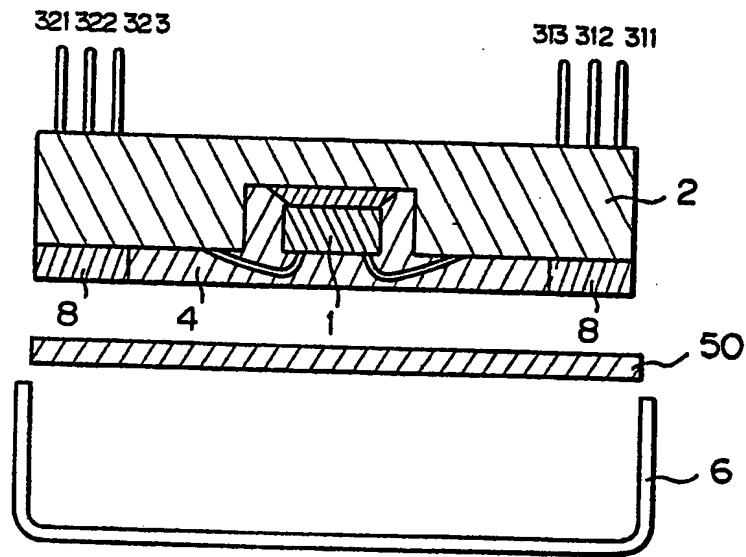


Fig. 7D

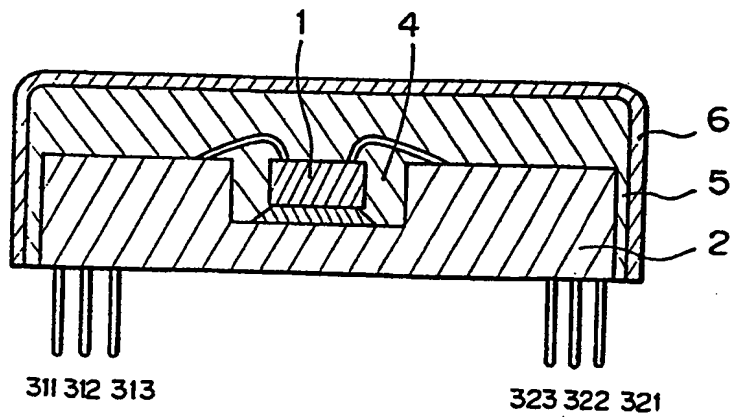


Fig. 8A

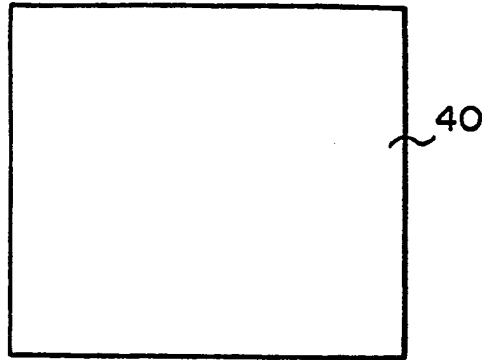


Fig. 8B

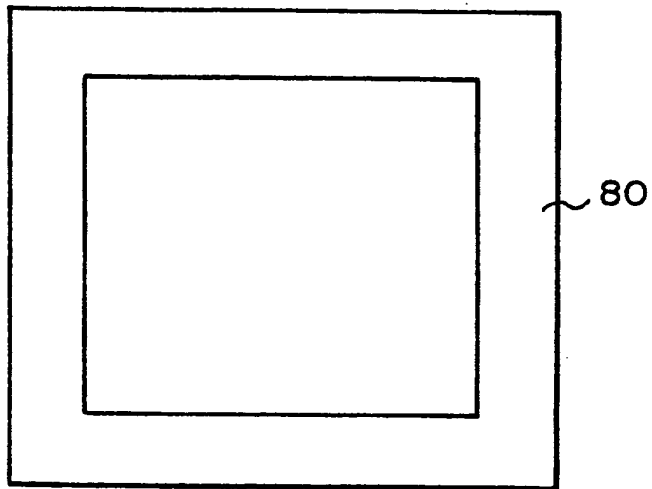


Fig. 8C

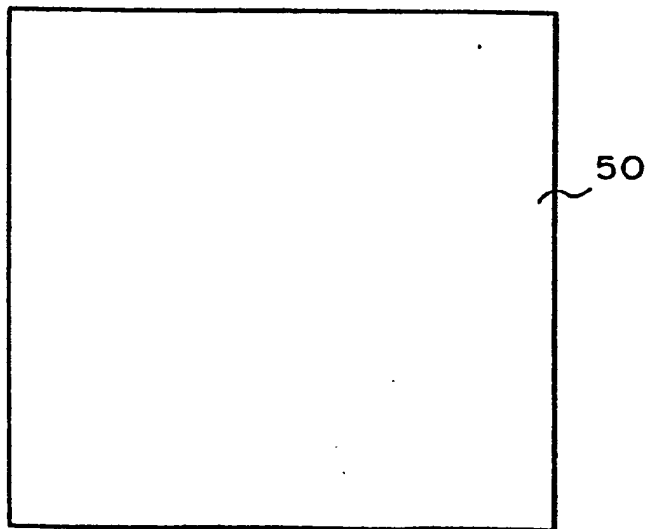


Fig. 9

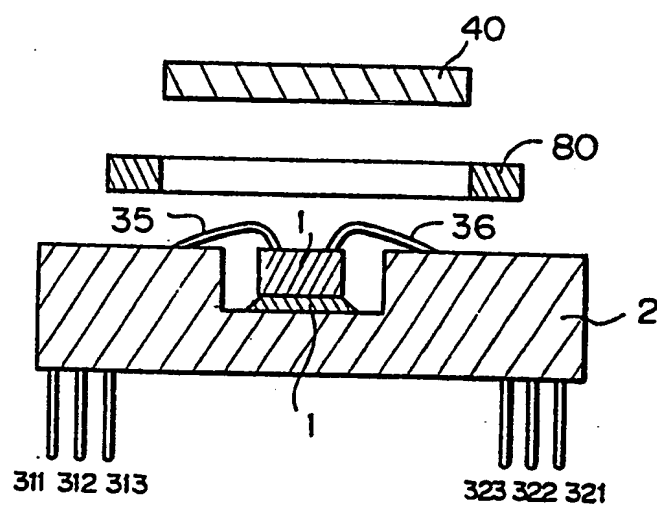


Fig. 12

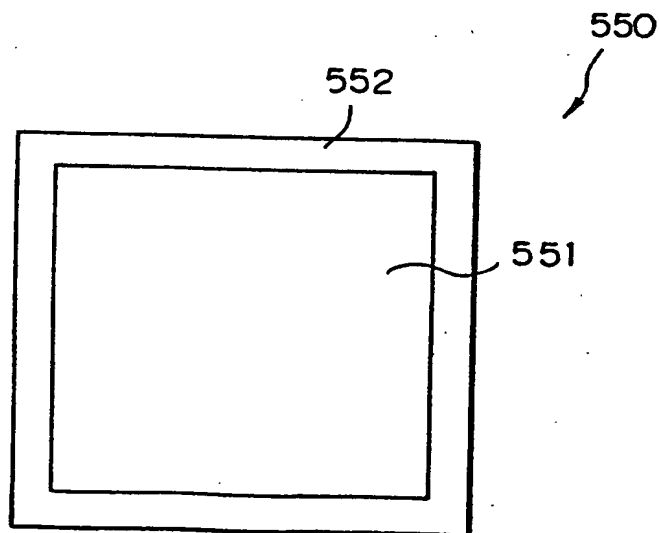


Fig. 10A

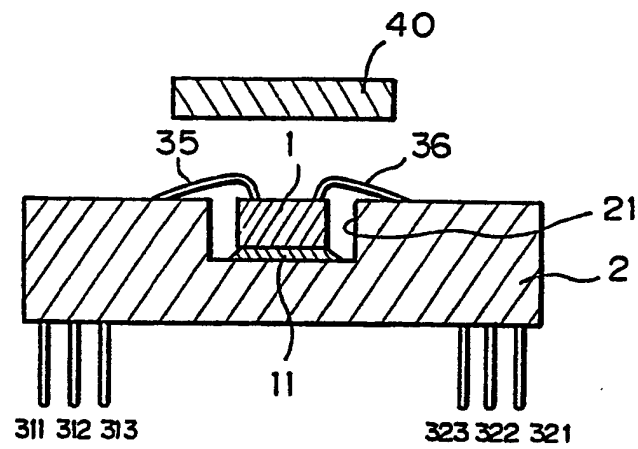


Fig. 10B

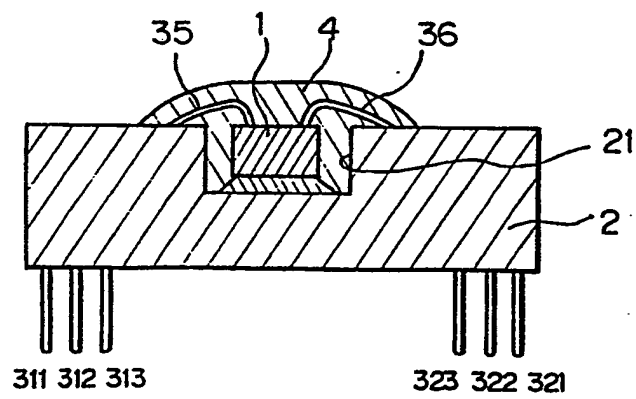


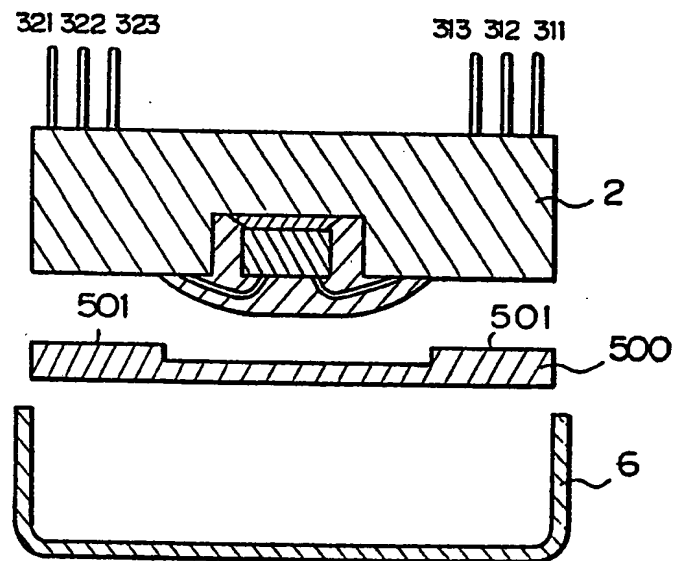
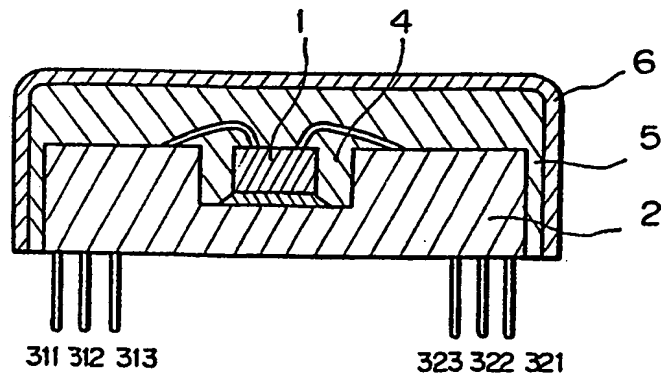
Fig. 10C*Fig. 10D*

Fig. 11A

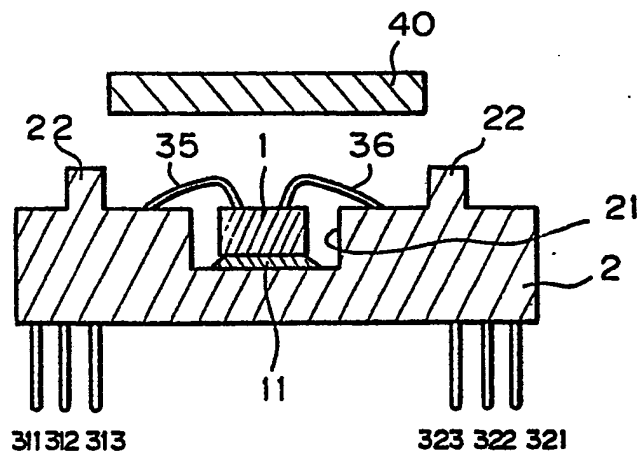


Fig. 11B

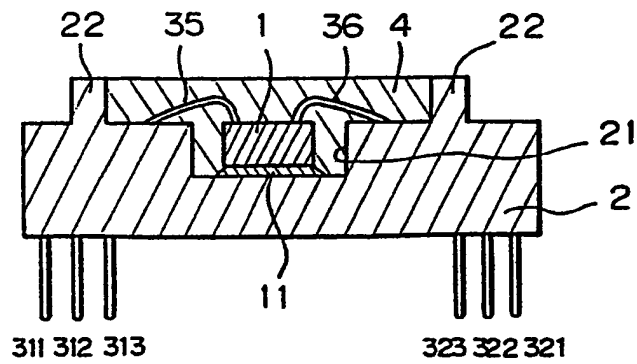


Fig. 11C

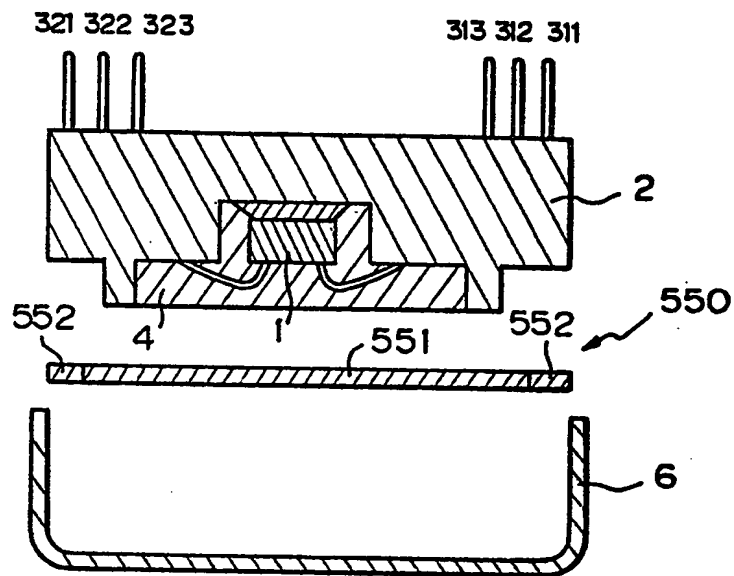
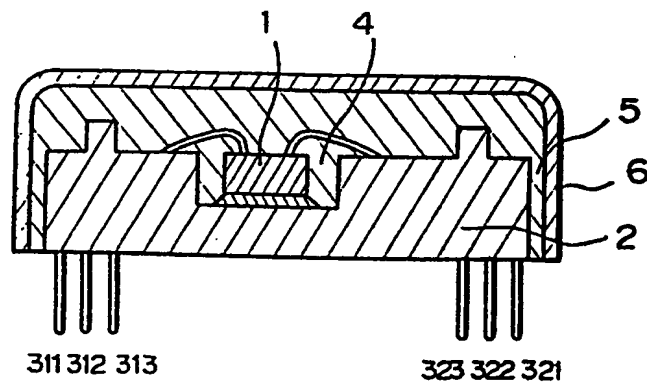


Fig. 11D



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